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FM 4–32

WAR DEPARTMENT

COAST ARTILLERY FIELD MANUAL

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SERVICE OF THE BASE-END DATA AND GUN DATA [redacted]SSION SYSTEMS

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COAST ARTILLERY FIELD MANUAL

SERVICE OF THE BASE-END DATA AND GUN DATA TRANSMISSION SYSTEMS

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TABLE OF CONTENTS

	Paragraph	Page
SECTION I. GENERAL.		
Scope	1	1
General	2	1
References	3	2
II. BASE-END DATA TRANSMISSION SYSTEM.		
General	4	2
Principles	5	3
Aided-drive mechanisms	6	5
Transmission circuit	7	7
Transmitters	8	9
Receivers	9	13
Line balancer M1	10	18
Power supply	11	18
Installation	12	19
Provision of wire facilities	13	19
Switching facilities	14	21
Operation	15	23
Maintenance	16	23
III. GUN DATA TRANSMISSION SYSTEM.		
Purpose	17	24
Component parts	18	25
Designation of systems	19	26
Theory of operation	20	27
Azimuth transmitter M5	21	29
Elevation transmitter M6 (formerly elevation transmitter M5)	22	30
Gun data computer transmitters	23	30
Azimuth indicators M5, M6, M9, and M16	24	31
Elevation indicators M5, M8, M10, and M17	25	32
Cables and junction boxes	26	32
Operation with standard transmitters	27	35
Operation with a gun data computer	28	35
Orientation	29	35
Synchronization of receivers with transmitters	30	36
Synchronization of two transmitters	31	37
Adjustment of parallax counters	32	38
Maintenance adjustments	33	39
Care and preservation	34	39
Miscellaneous	35	40
IV. DESTRUCTION OF MATERIEL.		
General principles	36	41
Base-end data transmission system	37	42
Gun data transmission system	38	42
APPENDIX I. LIST OF REFERENCES		43
II. DRILL FOR BASE-END DATA TRANSMISSION SYSTEM		44
III. DRILL FOR GUN DATA TRANSMISSION SYSTEM		46

FM 4-32, FEB. 1944

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COAST ARTILLERY FIELD MANUAL

SERVICE OF THE BASE-END DATA AND GUN DATA TRANSMISSION SYSTEMS

		Paragraphs
SECTION I.	General	1–3
II.	Base-end data transmission system	4–16
III.	Gun data transmission system	17–35
IV.	Destruction of materiel	36–38

SECTION I

GENERAL

	Paragraph
Scope	1
General	2
References	3

■ 1. SCOPE.—*a.* This manual contains information pertaining to the operation, care, and maintenance of the base-end data transmission system and the gun data transmission system.

b. Section II deals exclusively with the base-end data transmission system and covers theory of operation, description of component parts, operation, maintenance, and the adaptation of existing fire control communication systems for use with the data transmission system.

c. Section III deals exclusively with the gun data transmission system and covers theory of operation, description of component parts, and designation of the system according to the armament on which it is used. This section also covers the operation, maintenance, and adjustment of the equipment used.

■ 2. GENERAL.—*a.* The base-end data transmission system, operated on the principle of the voltage bridge, was developed for the purpose of transmitting continuous present

position data from base-end stations or fire control radar sets to a gun data computer. In the event that the computer fails, the data transmission equipment can be used to furnish azimuths to a plotting board on the time-interval system.

b. The gun data transmission system, operated on the principle of self-synchronous motors, was developed for the purpose of transmitting firing data from the plotting room to the guns. It may be used with a gun data computer to transmit continuous firing data or it may be used with the azimuth transmitter M5 and the elevation transmitter M6 to transmit firing data on a time-interval basis.

■ 3. REFERENCES.—The publications shown in the list of references, appendix I, contain additional information on the subjects dealt with in this manual.

SECTION II

BASE-END DATA TRANSMISSION SYSTEM

	Paragraph
General	4
Principles	5
Aided-drive mechanisms	6
Transmission circuit	7
Transmitters	8
Receivers	9
Line balancer M1	10
Power supply	11
Installation	12
Provision of wire facilities	13
Switching facilities	14
Operation	15
Maintenance	16

■ 4. GENERAL.—*a. Purpose.*—The base-end data transmission system is intended to furnish smooth and continuous data on the present position of a surface target to a gun data computer. At present the system is used with the gun data computers M1 and M8.

b. Capabilities.—The system is capable of transmitting data over lines with a D.C. loop resistance not in excess of about 5,000 ohms. In the case of 19-gage cable pairs, transmission over distances up to 50 miles is possible. In general, the system is capable of transmitting data with accuracy

equal to the least reading of the position finding equipment to which it is connected.

c. Component parts.—Although no specific group of components is described by standard nomenclature as a *base-end data transmission system,* such a system will include a transmitter attached to an observation instrument or radar set; a receiver attached to, or part of, a gun data computer; and certain other accessories discussed elsewhere in this section.

d. Wire facilities required.—Two pairs (four wires) are required in the transmission of each element of data (azimuth or range), from a transmitter at a base-end station or radar set to a receiver in the plotting room. These pairs must be metallic throughout, and no sources of power other than those within the system itself may be connected directly to the lines.

■ 5. PRINCIPLES.—In the base-end data transmission system, a transmitting potentiometer, the transmission line, two line-balancing resistors, a receiving potentiometer, a power source, and an indicating meter are connected to form a direct-current Wheatstone bridge. This circuit, in its simplest form, is illustrated on the diagram in figure 1. The transmitting potentiometer is installed on the observation instrument in such a manner that the contact arm rotates when the instrument is traversed; and the receiving potentiometer is located either in the computer or in a receiver attached to the computer with the contact arm connected mechanically to the input shaft of the computer. The total resistance of each potentiometer is high (19,600 ohms) with respect to the direct-current resistance of any line over which the system is likely to be operated. Thus, the circuit acts as a voltage bridge, with the result that normal variations of the line resistance do not introduce any appreciable error into the system. When the resistances of the line-balancing resistors are alike and equal to the line resistance plus that portion of the balancing resistance between the power source and the transmitting potentiometer, and when the contact arms of the potentiometers are

in corresponding positions, there is no voltage across the meter. Then, if the transmitting and receiving potentiometers are constructed alike, the position of the contact arm on the receiving potentiometer affords an indication of

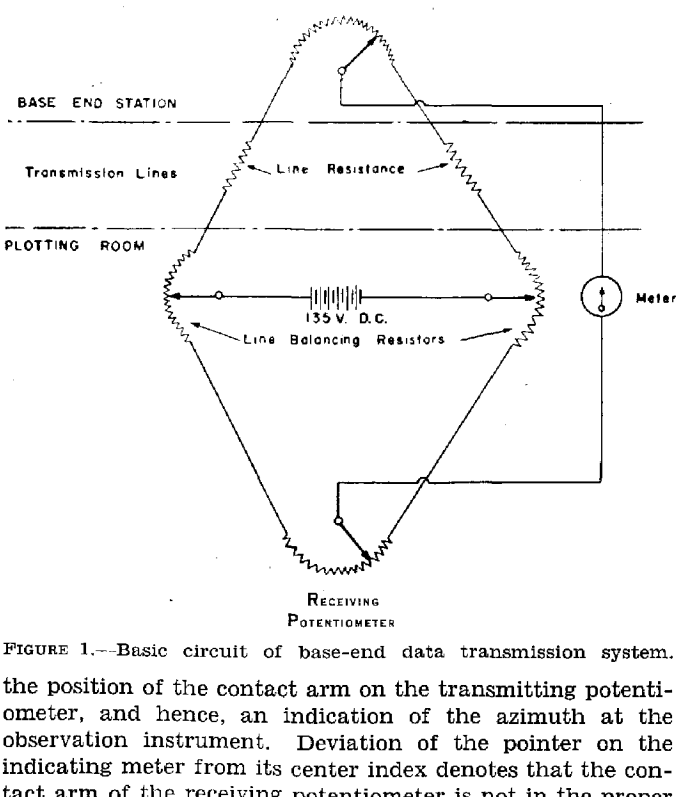

FIGURE 1.—Basic circuit of base-end data transmission system.

the position of the contact arm on the transmitting potentiometer, and hence, an indication of the azimuth at the observation instrument. Deviation of the pointer on the indicating meter from its center index denotes that the contact arm of the receiving potentiometer is not in the proper position for bridge balance, and also the direction the operating handwheel must be turned to restore the balance.

Azimuths are transmitted over the system in repeated cycles of 1°, there being 100 steps on the potentiometer, each step corresponding to 0.01°. Therefore, at the beginning of a course, the whole degree dial at the receiver must be set to correspond to the reading of the whole degree scale on the observation instrument. Synchronization of the transmitter and receiver to the correct whole degree is accomplished by telephone, and the operation is as described in appendix II. Since the degree and hundredths indicators on the observation instrument and on the computers are geared together mechanically, continuously maintaining the bridge in balance results in correct indication of the full azimuth reading at the receiver at all times.

■ 6. AIDED-DRIVE MECHANISMS.—*a. Purpose.*—The mechanism of gun data computers requires a smooth and continuous flow of input data for the generation of the smooth rates necessary for accurate prediction. To accomplish this smooth flow of input data, aided-tracking mechanisms have been included in the transmitters and aided-matching mechanisms in the receivers. In addition to providing smooth data, the aided-tracking mechanism on the observation instrument results in greatly reduced eye fatigue when an observer must track a target continuously for long periods.

b. Aided-tracking mechanism.—The aided-tracking mechanism consists of a traversing motor, a device for controlling the speed and direction of rotation of the motor, and mechanical gearing by means of which the rotary movements of the motor and the traversing handwheel are combined and applied to the traversing worm shaft of the observation instrument. Through this mechanism, rotation of the traversing handwheel controls the speed and direction of the motor and imparts direct displacement to the telescope of the observation instrument. The motor control includes a governor of the eddy-current, drag-disk type and three motor contacts. The two outer contacts are fixed in position, while the center contact is free to move between the outer contacts. (See fig. 4.) The center contact is mounted on the shaft of the governor and is held in position by two

springs. One end of one of the springs is attached to the housing, and the opposite end of the other spring is attached to a traveling nut on a lead screw. (See fig. 5.) The design of the control is such that the force exerted on the center contact by the springs is opposed by that exerted by the drag disk. Rotation of the traversing handwheel varies the spring tension through the action of the traveling nut and lead screw and causes the center contact to close on one or the other of the outer contacts. The motor is then energized and starts to run at full speed in the direction dictated by the movement of the traversing handwheel. As the motor accelerates, the force exerted by the drag-disk unit increases. When the force exerted by the drag disk becomes greater than that exerted by the springs, the closed contacts will open and the motor will coast. As the motor slows down, the force exerted by the drag disk decreases; and when it falls below that exerted by the springs, the contacts will again close. The speed of the motor fluctuates slightly as a result of this intermittent opening and closing of the contacts, but the fluctuations are so small as to be almost indistinguishable; and the observation instrument can be traversed smoothly at any speed between zero and a maximum of about 1° per second. Maximum speed is attained when the traversing handwheel is rotated about nine turns from the dead stop position, at which point the resultant spring tension is greater than the maximum force which can be exerted by the drag-disk unit.

c. Aided-matching mechanisms.—The aided-matching mechanisms in the receivers for the gun data computer M1 are similar to the aided-tracking mechanisms on the observation instruments. Major differences are the use of a larger motor, required to provide the necessary torque on the computer input shaft; and a slewing key, used in synchronizing the receiver and transmitter to the nearest whole degree. The aided-matching mechanisms in the M8 computer utilize a mechanical variable speed drive, of the type used in antiaircraft directors, for the control of the output of the driving motor; and have handwheels for changing the azimuth during synchronization in increments of 1°. The actions

of the matching handwheels in both the M1 and M8 computers are identical as far as the data introduced into the computer are concerned.

■ 7. TRANSMISSION CIRCUIT.—The actual circuit of the data transmission system is somewhat more elaborate than the simple basic circuit shown in figure 1. The simplified schematic diagram of this circuit appears in figure 2. The following major additions to the basic circuit have been incorporated:

a. Two contact arms or brushes are used at each potentiometer. This double brush arrangement overcomes certain disadvantages inherent in the use of potentiometers in data transmission systems. If a single-brush transmitter and a single-brush receiver were used, and if they were not synchronized, a violent movement of the meter pointer would result when the brushes pass over the ends of the potentiometers, because the full voltage of the system would be impressed momentarily on the meter. In the circuit shown in figure 2, the indicating circuit is transferred from one wire of the meter pair to the other in such a manner that the meter is always connected to the pair of brushes which is traversing the halves of the potentiometers which do not include the potentiometer terminals. This switching is accomplished in a microswitch driven by a cam geared to the receiving potentiometer. The microswitch actuates a relay which transfers the meter to the appropriate pair of brushes at positions corresponding to 0.75° and 0.25°, the ends of the potentiometers being connected to points corresponding to 0.49° and 0.51°. The potentiometer contact corresponding to 0.50° is not connected to the rest of the potentiometer in order to avoid short-circuiting the 135-volt supply when the brushes are bridging the contacts corresponding to 0.50° and 0.51°.

b. A circuit for use in balancing the line resistance is included. The circuit includes several double-pole, double-throw switches at the transmitter and at the receiver. When the BAL-TRACK switch at the transmitter is in the BAL position, the line-balance switch in the receiver is used

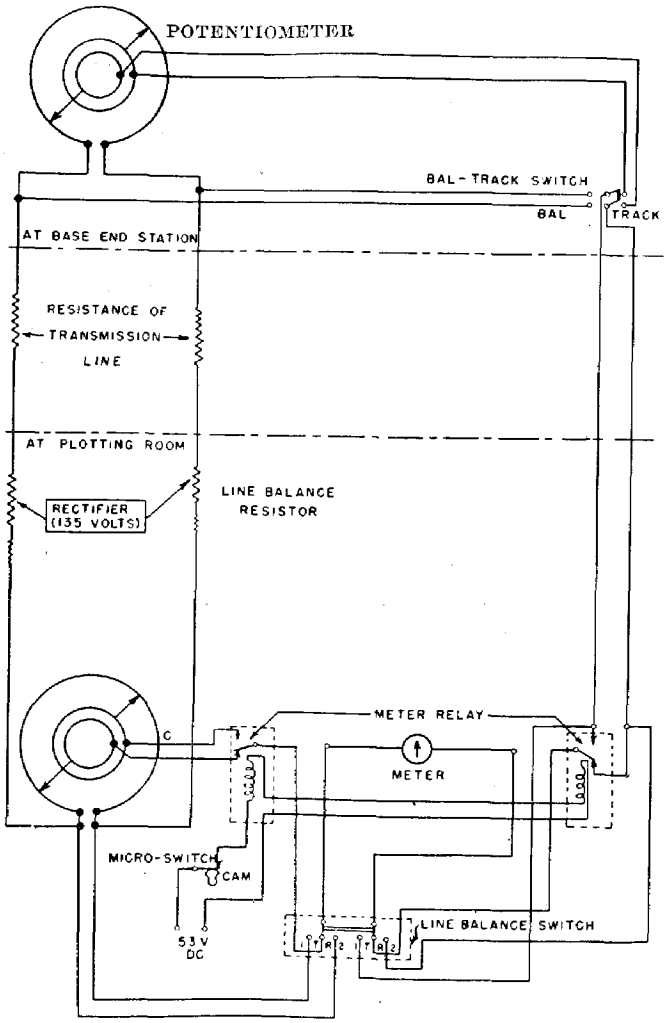

FIGURE 2.—Schematic diagram of base-end data transmission system.

to connect the meter alternately to corresponding ends of the transmitting and receiving potentiometers. The meter then furnishes an indication of the equality of the total resistance between the point of application of power and the ends of the potentiometers connected to that wire. Since the adjustments of the resistance in the two wires are not completely independent, first one line-balancing resistor and then the other is adjusted by manipulating the line-balancing switch and resistors, and the process is repeated until no further readjustment is necessary.

■ 8. TRANSMITTERS.—Azimuth transmitters have been developed for the azimuth instrument M1910A1 and the depression finder M1. No range transmitter for depression position finders has been developed, as the nonuniform range scale of the instrument does not lend itself readily to the use of transmitters of the potentiometer type. Azimuth and range transmitters are under development for the radio set SCR-296-A and for other fire control radar sets being developed for batteries equipped with gun data computers.

a. Azimuth transmitter M7.—(1) The azimuth transmitter M7 is used with the azimuth instrument M1910A1. When modified by the addition of the azimuth transmitter M7, this instrument is designated the azimuth instrument M2. The azimuth transmitter M7 is shown in figure 3.

(2) The azimuth transmitter M7 consists of three major assemblies, the motor assembly, the transmitter assembly, and a terminal box (not shown in the figure). The motor is a 115-volt, 1/60-horsepower, split-phase, capacitor-type induction motor. The motor mounting bracket contains a terminal strip for the connection of the cable from the terminal box, the wiring to the transmitter housing, and the motor leads. The transmitter assembly contains a transmitting potentiometer, aided-tracking controls, a differential, the traversing handwheel, and miscellaneous gearing. The transmitter housing with the side cover removed is illustrated in figure 4. This view shows the potentiometer contacts, the potentiometer brush assembly, and the motor

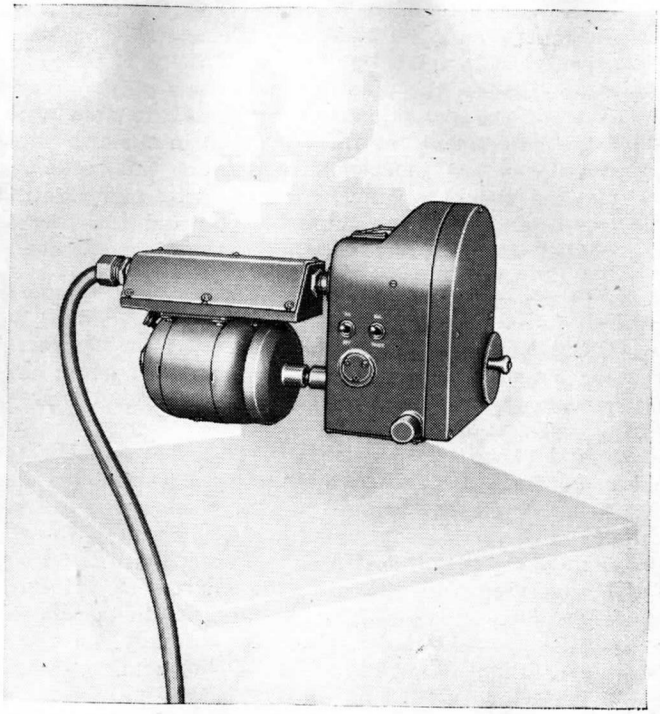

FIGURE 3.—Azimuth transmitter M7.

contacts. The center motor contact is mounted on the shaft of the armature of the drag-disk unit, and the contact mounting is attached mechanically to the springs controlling the average motor speed. This arrangement is illustrated in further detail in figure 5, which shows the transmitter assembly with the bottom cover plate removed. One end of the spring assembly is fastened to the housing and the other to a traveling nut on a lead screw driven by the operating handwheel through a worm gear. The drag-disk

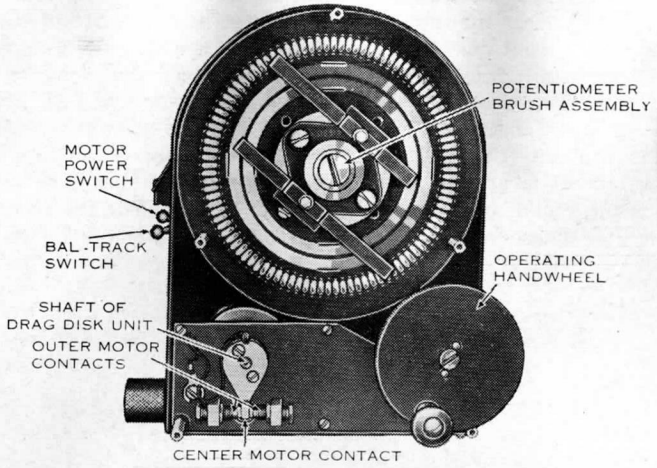

FIGURE 4.—Transmitter housing, end view.

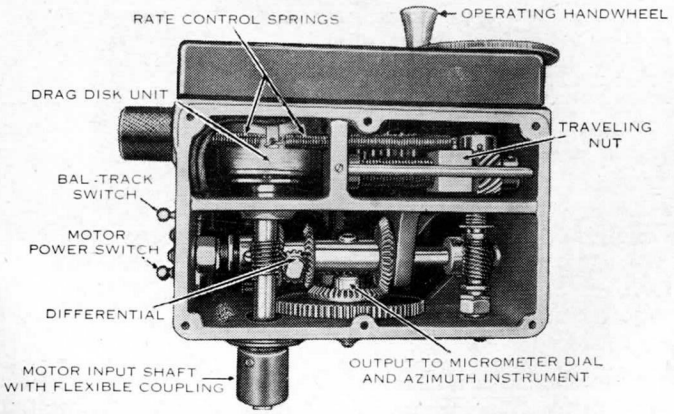

FIGURE 5.—Transmitter housing, bottom view.

assembly is removable as a unit for servicing. The lower half (inside as mounted on the azimuth instrument) of the assembly contains the gear train of the aided-tracking mechanism. Movement of the handwheel displaces the driving gear shown at the bottom of the figure and, at the same time, changes the average speed of the motor through the drag-disk control and spring mechanism. The direct movement is applied to one input of the differential while the movement imparted by the motor is applied to the other input. These movements are combined in the differential and drive the output through bevel gearing. The output

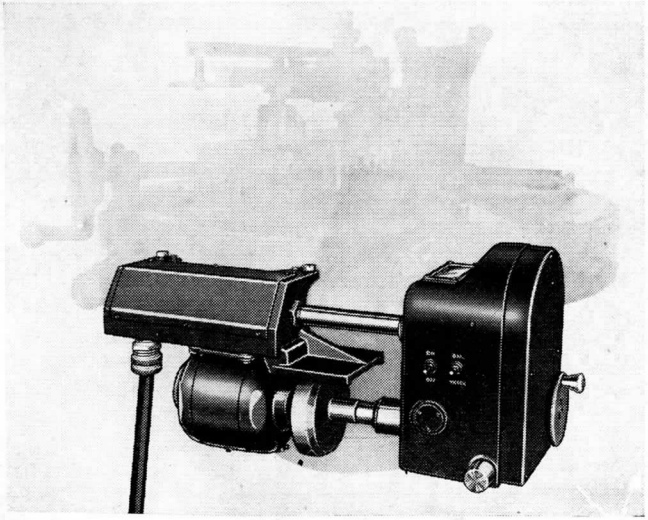

FIGURE 6.—Azimuth transmitter M8.

gear meshes with a gear on the worm shaft of the azimuth instrument. The terminal box contains the motor capacitor, a fuse for the 115-volt A.C. power supply, the elements of an interference suppressor circuit, and a terminal strip. The

box is equipped with two cords, one for connection to the 115-volt supply and one for connection to the data transmission lines at the cable terminal box.

b. Azimuth transmitter M8.—(1) The azimuth transmitter M8 is used with the depression position finder M1. When modified by the addition of the azimuth transmitter M8, the instrument is designated the depression position finder M2. The azimuth transmitter M8 is shown in figure 6.

(2) The azimuth transmitter M8 consists essentially of the same parts as the azimuth transmitter M7. The main difference is that a slightly different mounting bracket and transmitter housing collar are required because of differences in the shapes of the rear portions of the bases of the depression position finder M1 and the azimuth instrument M1910A1.

■ 9. RECEIVERS.—The azimuth receiver M13 and the azimuth-range receiver M12 are used with the gun data computer M1. Receivers for the gun data computer M8 are incorporated in the computer and have no separate designation. The two types of receivers for the M1 computer are shown in figure 7.

a. Azimuth receiver M13.—(1) The azimuth receiver M13 is used to furnish azimuth to the A- and C-triangle solvers of the M1 computer. The unit rests on the floor of the plotting room and is bolted to the computer in such a position as to permit coupling to the input handwheel shaft. The receiver is provided with a clutch which, in case of failure of the computer mechanism, may be released by turning a hexagonal nut on the front of the receiver. The base-end data transmission system can then be operated independently of the computer. The receiver is equipped with a dial stop button by which the azimuth dials may be stopped and read at the sounding of the time-interval signal and the azimuth transmitted to plotting board arm setters. When the dial stop button is released the dials return to their correct position at the instant of release.

(2) The receiver consists of three units which, when assembled, comprise an assembly about 9 inches wide, 8

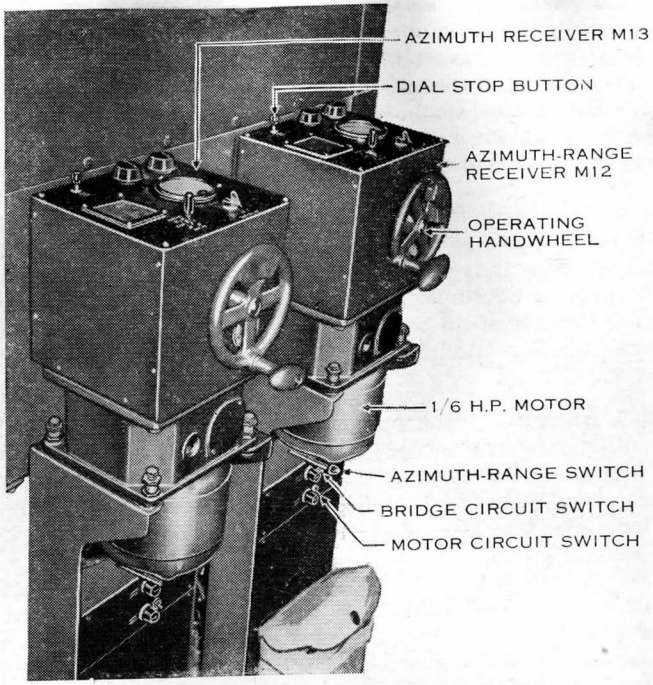

FIGURE 7.—Receivers on gun data computer M1.

inches deep, and 40 inches high. An adapter plate, furnished with the receiver, is bolted to the handwheel unit of the computer by means of holes drilled and tapped in the handwheel unit at the time of manufacture. The receiver, in turn, is bolted on the adapter plate and is held in an upright position by means of a bracket clamped to the frame of the computer. The top unit of the assembly contains the receiving potentiometer, the aided-matching controls, the slewing control, indicating meter, degree and hundredths dials, and line-balancing equipment. The middle unit con-

tains the motor flywheel and coupling, and the studs for adjusting the height of the top unit so as to permit proper alinement of the driving gear with the input shaft of the computer. The bottom unit, or pedestal, contains a 115-volt, 1/6-horsepower, split-phase, capacitor-type induction motor, terminal blocks, the power supply equipment, and terminal strips. Figure 8 is a close-up view of the top unit of the

FIGURE 8.—Top unit of azimuth receiver M3.

receiver. The line-balancing switch is in front of the meter, and the knobs of the line-balancing resistors are in the rear of the meter. The slewing key is at the left front of the panel, the degree and hundredths dials appear under the window at the left center of the panel, and the dial stop button is at the left rear of the panel. The handwheel shown in the figure is removed from the computer and installed on the receiver. The hexagonal nut of the decoupling clutch is partly visible under the handwheel. Figure 9 shows the receiver with the indicating panel removed. The line lock located on the handwheel shaft prevents the handwheel from backing up when the computer imposes a heavy load on the output shaft of the unit. The motor governor contact and spring control are shown in the center of the figure. The potentiometer is mounted vertically at the extreme right and the degree and hundredths dials are located at the

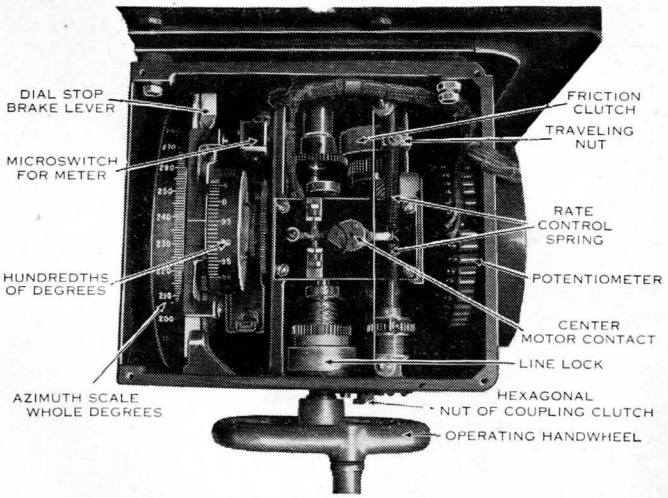

FIGURE 9.—Azimuth receiver M13 with top panel removed.

extreme left of the unit. The mechanical schematic diagram of the aided-matching mechanism is shown in figure 10. The mechanism is similar to the aided-tracking mechanism in the transmitters. The main drive shaft is equipped with a friction clutch to prevent damage to the receiver in case of seizure or breakage in the computer mechanism.

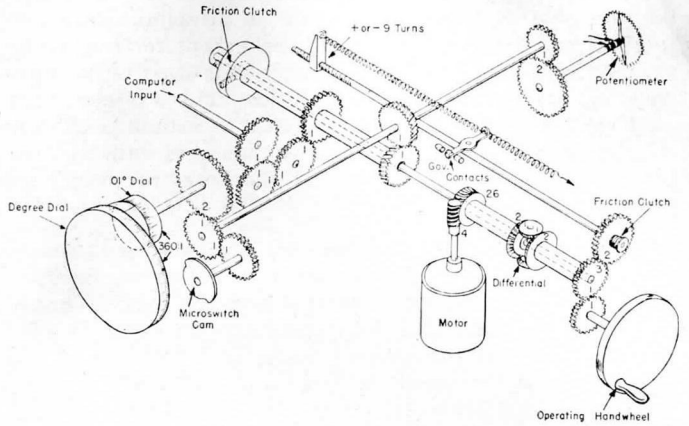

FIGURE 10.—Schematic diagram of aided-matching mechanism, azimuth receiver M13.

b. Azimuth-range receiver M12.—The azimuth-range receiver M12 is identical to the azimuth receiver M13, except for the addition of a change-over switch which is operated when receiving range from a radar set. This receiver is connected to the B-triangle solver of the M1 computer. The AZIMUTH-RANGE change-over switch, when on the RANGE position, transfers the connections to the indicating circuit from the azimuth potentiometer in the receiver to a range potentiometer mounted on the CT shaft inside the computer. The aided-matching mechanism of the M12 receiver is then used to vary the azimuth introduced into the C-triangle solver in such a manner as to cause the correct range to be indicated on the CT range counter. This occurs when the contact arm of the range-receiving potentiometer

in the computer is in the proper position, as indicated by the meter on the M12 receiver. Included as part of the azimuth-range receiver M12 is a terminal box equipped with terminal strips and cables for the connections to the power and data transmission lines. This terminal box is mounted on the lower frame of the M1 computer.

c. Receivers in gun data computer M8.—The receivers in the gun data computer M8 operate on principles similar to those of the M12 and M13 receivers, except for the use of variable speed drives instead of drag-disk-type motor controls and mechanical slewing facilities. These receivers are used for the reception of either range or azimuth, and the circuits are so arranged that two receivers can be connected to a single transmitter at the base-end station or radar set.

■ 10. LINE BALANCER M1.—Means for line balancing prior to the operation of the data transmission system are incorporated in the azimuth receiver M13 and the azimuth-range receiver M12. The gun data computer M8 contains four receivers, so that the present range and azimuth of the target may be computed for input data received from two base lines simultaneously. If the two base lines have one station common to both, provision is made for connecting two of the receivers to the data transmission lines from this station. Because of these characteristics, line-balancing facilities cannot be included in the receivers and are provided in a separate unit designated the line balancer M1. In this line balancer, the circuits are designed so that the data transmission lines from any of six base-end stations may be connected to any of the four receivers of the M8 computer; and the lines to the base-end stations can be balanced before connection to the computer. Lines to any base-end station can be balanced while other lines terminating in the unit are connected to the computer.

■ 11. POWER SUPPLY.—Power for the transmission of data is furnished by rectifiers in the M12 and M13 receivers and in the line balancer M1. The rectifiers operate on 115-volt alternating current and furnish 135-volt direct current to

the potentiometers through the adjustable contacts of the line-balancing resistors. The aided-tracking and matching motors operate on 115-volt alternating current furnished to them at their respective places of installation.

■ 12. INSTALLATION.—*a. Transmitters.*—Transmitters are supplied in kit form for installation in the field on observation instruments and radar sets. The transmitters for the azimuth instrument M1910A1 and the depression position finder M1 are installed by local Ordnance personnel, while the transmitters for radar equipment will be installed by Signal Corps installation personnel or harbor defense radar maintenance personnel.

b. Receivers.—The receivers for the gun data computer M8 are components of that computer and will be found installed in the computer when it is received. The M12 and M13 receivers will be furnished as accessories to the gun data computer M1 and will be installed on the computer in the field by local Ordnance personnel.

■ 13. PROVISION OF WIRE FACILITIES.—*a. Existing facilities.*—(1) *To base-end stations.*—Base-end stations are provided with a minimum of three fire control pairs, one for an observer's line, one for a reader's line, and one for time-interval signals. Each base-end station used also as a spotting station will be provided with an additional pair for the use of the spotter. In many cases, additional pairs will have been laid as a precautionary measure and to provide for expansion in the fire control system in the harbor defense.

(2) *To radar sets.*—Minimum fire control cable facilities from fire control radar sets may include 6 pairs: a command line from the plotting room, a range reader's line, an azimuth reader's line, a TI line, a range spotter's line, and an azimuth spotter's line. Since most radar sets have been installed relatively recently, and provision of communication facilities to them has required extension of existing facilities, they usually will be found to be connected by new multi-pair cables. These new cables frequently will contain 11 or more pairs.

b. Provision for data transmission lines.—(1) *New construction.*—In new construction, two pairs for each element of data to be transmitted should be provided in addition to the pairs necessary for telephonic communication. If additional pairs are provided, circuits necessary for transmission of data by telephone may be retained as a precaution against failure of the base-end data transmission system.

(2) *From azimuth instruments M2.*—If no additional pairs can be provided, the reader's line and the TI line must be used for data transmission. A telephone circuit between the base-end station and the computer is required in synchronizing the transmitter and the receiver, as well as for occasional checks of synchronism during tracking. At the beginning of the course, the spotter's line may be used for synchronization, but after firing has commenced, this line is no longer available. Consequently, additional pairs should be provided if available; otherwise, a telephone circuit should be superimposed on the data transmission pair containing the potentiometers, by the use of standard repeating coils, such as the coil C-111, and a suitable condenser to bypass the potentionmeters. This condenser should be of at least 2 mf. capacitance.

(3) *From depression position finders M2.*—Since ranges are not transmitted from the depression position finder M2, the time-interval line and the reader's line must be retained at base-end stations at which these instruments are installed. Two additional cable pairs should be provided to these stations, although one additional pair can be made to suffice if a reader's circuit is superimposed on the base-end data transmission system and the present reader's line is used for data transmission.

(4) *From radar sets.*—At least one additional cable pair must be provided to each fire control set. This pair, the two readers' pairs, and the time-interval pair, are required for transmission of range and azimuth over the base-end data transmission system. Present spotter's lines must be retained. It would be preferable to provide four extra pairs for automatic data transmission so that the complete telephone

and time-interval systems could be retained as a precaution against failure of the base-end data transmission system.

■ 14. SWITCHING FACILITIES.—Two pairs of lines must be switched each time connections to the base-end data transmission system are changed. This switching is accomplished in a switchboard BD-95, slightly modified for this application, in the case of lines connected to the gun data computer M1; and in the line balancer M1, in the case of lines connected to the gun data computer M8.

a. Switchboard BD-95.—(1) The switchboard BD-95 will accommodate the transmission lines to 10 base-end stations. In the case of those few batteries having more than 10 base-end stations, additional switchboards BD-95 will have to be used. The BD-95 contains circuits for 20 incoming lines and 6 connecter or bus-bar circuits, one of which is used for applying ringing signals to the incoming lines. The incoming line circuits and 5 of the connecter circuits are equipped with 2 supervisory relays, one of which is connected directly across the incoming line or connecter circuit as the case may be. Since the supervisory relays constitute low impedance shunts across the lines and connecter circuits, the windings must be disconnected when the switchboard is used with the base-end data transmission system.

(2) Each of the connecter circuits is divided in two between the tenth and eleventh incoming lines, and one-half may be used for the connections to lines 1 to 10 inclusive, while the other is used for the connections to lines 11 to 20 inclusive. The two halves of each of three connecter circuits are connected permanently to one of the receivers of the M1 computer. The half connected to the pair containing the receiving potentiometers is used in switching the base-end station pairs containing the transmitting potentiometers, and the half connected to the meter circuit pair at the receiver is used in switching the meter pairs to the base-end stations. Thus, to connect the transmitter to the receiver, two keys must be operated. Care must be exercised in operating the switchboard to see that no keys other than

the proper incoming line keys are operated, either intentionally or accidentally, as the base-end data transmission system then will not operate properly. Figure 11 shows a switchboard BD-95 with the keys in the proper position to connect the lines from base-end station No. 1 to the receiver on the A-input of the computer.

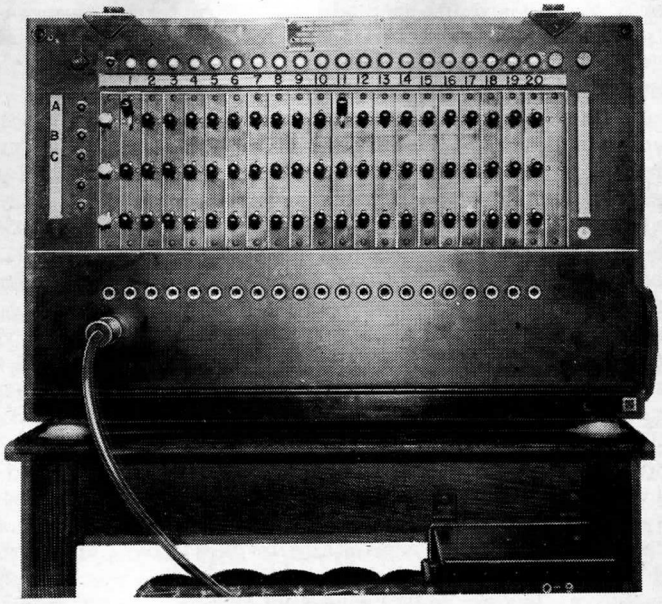

FIGURE 11.—Switchboard BD-95.

b. Line balancer M1.—The line balancer M1 contains incoming line facilities for the data transmission lines to six base-end stations. Lines from any of these stations can be connected to the line-balancing meter and switch, as well as to any of the four inputs to the M8 computer. Two receivers, one from each of the triangle solvers in the M8 computer, may be connected to the lines from any of the base-end stations by the operation of appropriate keys. The line

balancer includes switches for applying 135-volt, direct-current power to the potentiometer pairs from the base-end stations.

■ 15. OPERATION.—*a. With gun data computers.*—The sequence of operations in line-balancing, synchronization, and transmission of data for systems connected to the gun data computer M1 is shown in detail in the drill table, appendix II. The various operations are numbered in the order in which they are performed. The operation of systems used with the gun data computer M8 is essentially the same, except that the lines are balanced before they are connected to the receivers in the computer, line-balancing operations are performed at the line balancer M1, and slewing at the receiver is accomplished by means of a handwheel instead of a slewing key. In the case of systems used with the M8 computer, the lines to all base-end stations can be balanced before the particular stations to be used are designated. In the case of the M1 computer, line balancing must be delayed until the stations are connected to the various receivers on the computer.

b. With plotting board.—In case of failure of either the M1 or the M8 computer to operate properly, data displayed on the receivers may be read on time-interval signals and plotted on standard plotting boards. Operation of the base-end data transmission system is the same as when the computers are used, except that, on the time-interval bell, the dial stop buttons are depressed and the data are read to plotting board arm setters. When the buttons are released, the receiver dials return automatically to their correct positions at that instant. The pointers on the aided-matching meters are put at their center indexes at all times in the usual manner. In case of seizure or breakage of the mechanism in the M1 computer, the M12 and M13 receivers can be disconnected quickly by turning the hexagonal nut shown in figure 9, thus releasing the coupling clutch.

■ 16. MAINTENANCE.—The data transmission equipment installed on observation instruments and computers should be accorded the same care and preventive maintenance

as the equipment on which it is mounted. Mechanisms in the transmitters are similar to those in the observation instruments, and the receiver mechanisms are similar to those in the computer. Directions for lubrication and maintenance contained in Ordnance pamphlets should be followed explicitly. Precautions should be taken to keep dust and dirt out of the base-end data transmission equipment. The contacts in the motor control circuits should be kept clean, and if the outside contacts become pitted after a considerable period of operation, they should be turned slightly so that the wear comes in a different place. In case of excessive pitting, contacts should be filed smooth with a fine flat file and burnished. If the base-end data transmission system is not to be used for a long period, the aided-tracking or matching motors should be run for a period of at least 15 minutes each week.

SECTION III

GUN DATA TRANSMISSION SYSTEM

	Paragraph
Purpose	17
Component parts	18
Designation of systems	19
Theory of operation	20
Azimuth transmitter M5	21
Elevation transmitter M6 (formerly elevation transmitter M5)	22
Gun data computer transmitters	23
Azimuth indicators M5, M6, M9, and M16	24
Elevation indicators M5, M8, M10, and M17	25
Cables and junction boxes	26
Operation with standard transmitters	27
Operation with a gun data computer	28
Orientation	29
Synchronization of receivers with transmitters	30
Synchronization of two transmitters	31
Adjustment of parallax counters	32
Maintenance adjustments	33
Care and preservation	34
Miscellaneous	35

■ 17. PURPOSE.—*a.* The gun data transmission systems herein discussed were designed to reproduce at the guns the firing data as calculated and set on the transmitter at the plotting room. In addition to transmitting the firing data to

the guns, the systems provide for setting data on the guns by a match-the-pointer system. The systems lessen the possibility of personnel errors in the transmission of firing data, provide an accurate means for setting the piece, and when used with a gun data computer, permit the firing of the piece without reference to a time-interval bell.

b. The gun data transmission systems are equipped to be used in conjunction with standard plotting room equipment or gun data computers.

■ 18. COMPONENT PARTS.—A complete gun data transmission system (see figs. 12 and 13) consists of an elevation transmitter, an azimuth transmitter, a main junction box, extension junction boxes when required, the necessary connecting cable, and at each gun an emplacement junction box, a gun junction box, an azimuth indicator, and an elevation indicator. Gun data computers are equipped with azimuth and elevation transmitters, but batteries equipped with gun data computers will, in addition, be issued the standard elevation and azimuth transmitters for use with standard plotting room equipment.

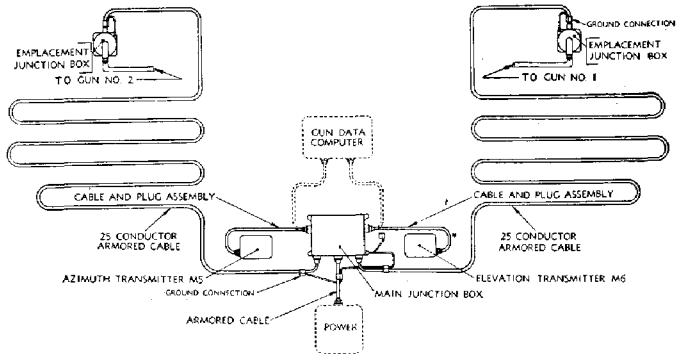

FIGURE 12.—Cable system from plotting room to the emplacement junction boxes.

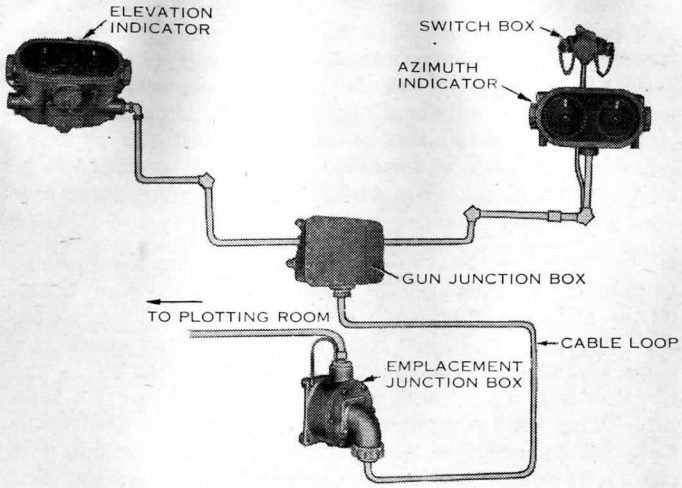

FIGURE 13.—Cable system from emplacement junction box to indicators.

■ 19. DESIGNATION OF SYSTEMS.—*a.* The gun data transmission systems for the various carriages, and the indicators which are components of these systems, are listed below. The azimuth transmitter M5 and the elevation transmitter M6 (formerly the elevation transmitter M5) are components of each of the systems and are for use with the standard plotting room equipment. The transmitters contained in gun data computers are not separately designated.

b. It should be noted that all the azimuth indicators and all the elevation indicators listed are merely adaptations of the same indicator to the various carriages. The only differences between the azimuth or elevation indicators are in the mechanical means of attaching the indicators, the gun junction boxes, and the interconnecting cable to the carriages, and in the drive mechanisms to the azimuth and elevation mechanical indicators. The same main junction boxes, emplacement junction boxes, gun junction boxes, and extension junction boxes are used, when required, in the

Data transmission system	Carriage	Indicators	
		Azimuth	Elevation
M5	16-inch barbette carriages M1919M1, M2, M3, and M4.	M6	M5
M5	16-inch barbette carriage M1919 (1 plotting room)...	M6	M10
M7	6-inch barbette carriage M1 (hydraulic).....	M9	M8
M7B1	6-inch barbette carriage M3 (hydraulic).....	M9	M8
M8	8-inch barbette carriage M1.....	M5	M5
M9	8-inch railway mount M1A1.....	M5	M5
M10	12-inch barbette carriage M1917 (2 plotting rooms).	M6	M10
M13	16-inch howitzer carriage M1920.....	M16	M17
M14	16-inch barbette carriage M1919 (2 plotting rooms).	M6	M10
M15	6-inch barbette carriages M1900 and M1910.....	Types not determined.	
M17	12-inch barbette carriage M1917 (1 plotting room)..	M6	M10

various systems. The different lengths of interconnecting cable required by the different emplacements, and the different mounting of indicators required by the various carriages make it necessary to designate each system separately.

■ 20. THEORY OF OPERATION.—*a.* The operation of the gun data transmission systems is based on the use of self-synchronous transmitters and receivers. The transmitting and receiving selsyns are very similar in construction and appearance and are identical electrically.

b. A transmitter and receiver are shown schematically in figure 14. The stator or secondary winding of each unit is a three-terminal, Y-connected winding which is essentially three windings separated electrically by 120°. The rotor or primary winding of each unit is a single two-terminal winding. Corresponding terminals of the two stator windings are

connected together, and corresponding terminals of the two rotor windings are connected together. The two rotor windings are energized from a common source and no current is supplied directly to the stator windings.

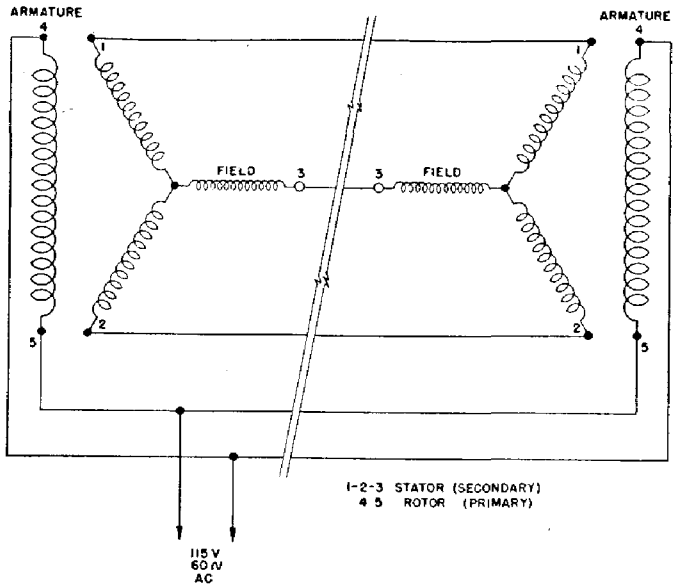

FIGURE 14.—Schematic diagram of gun data transmission system.

c. When the fields are energized, each unit acts as a transformer, and voltages are induced in each of the three stator windings of both units. The magnitude of the voltage induced in each winding is dependent on the relative angular position of the rotor with respect to the stator; and at any angular position the combination of voltages induced is peculiar to that position.

d. If the transmitter and receiver rotors are in the same angular position with respect to their stators, the voltage across each corresponding pair of stator terminals is the

same and therefore no current flows in the armature circuit. There is consequently no magnetic reaction between stator and rotor and no developed torque. On the other hand, if the two rotors are not in the same relative angular position, the voltages induced in corresponding stator windings are not the same and the voltage difference produces a circulating current in the stator windings. The magnetic flux produced by this current reacts with the flux of the energizing current in the rotors to develop torques in such direction that they tend to bring both rotors to the same relative positions. The rotor of the transmitter is mechanically held and this results in the receiver's rotor being forced to a position identical to that of the transmitters. A damping device in each receiver prevents prolonged oscillation of the receiver about its final position.

■ 21. AZIMUTH TRANSMITTER M5.—The component parts of this transmitter are a coarse selsyn transmitter (with dial) and a fine selsyn transmitter (with dial) for each of two guns, a coarse and a fine dial for setting in (firing) azimuths for the D.P. and two parallax counters for setting in parallax corrections. The (firing) azimuth from the directing point to the target is set on the AZIMUTH dials provided by means of the handwheel shown in figure 15. The parallax correction required by each gun for displacement from the directing point is set on the corresponding parallax counters by means of knobs similar to those in figure 15. It should be noted that the No. 1 gun is normally the D.P. and requires no parallax correction. Differential gearing adds each parallax correction algebraically to the set azimuth and positions the corresponding TRANSMITTED AZIMUTH dials accordingly. The firing azimuth for each gun then appears on the TRANSMITTED AZIMUTH dials. One revolution of each coarse azimuth dial is 360° and one revolution of each fine dial is 10°. The coarse dials are graduated and numbered every 10°, and the fine dials are graduated every 0.05° and numbered every 0.10°. The three digits of the parallax counters are degrees, tenths, and hundredths. The transmitter unit has READY SIGNAL switches which, when

turned on, light the signal lights at the transmitter and at the receivers to indicate that the transmitted azimuths are correct firing data.

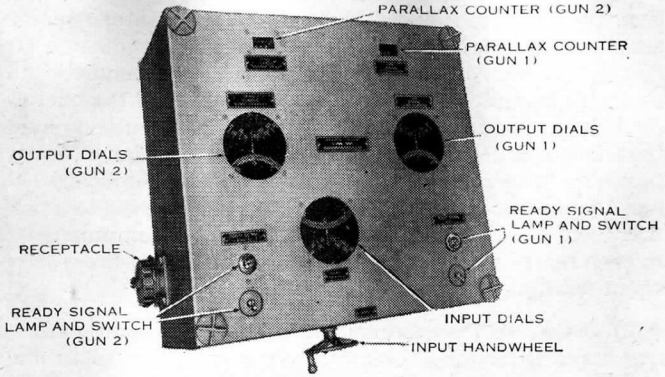

FIGURE 15.—Azimuth transmitter M5.

■ 22. ELEVATION TRANSMITTER M6 (FORMERLY ELEVATION TRANSMITTER M5).—The elevation transmitter unit is very similar to the azimuth transmitter unit. It contains a coarse and a fine transmitter for each of two guns. One revolution of each coarse transmitter dial is 1,600 mils, the dial being graduated and numbered in 100-mil steps. One revolution of each fine transmitter dial is 100 mils, the dial being graduated in mils and numbered at each 10 mils. The quadrant elevation is set on the ELEVATION dial and also appears on the adjacent counter. The parallax corrections in mils are set in by means of the parallax knobs (see fig. 16), and added algebraically to the set elevation to produce the transmitted elevation which appears on the TRANSMITTED ELEVATION dials. As in the case of the azimuth parallax correction, no elevation parallax correction is required for gun No. 1 when it is the D.P. READY SIGNAL switches are provided as for the azimuth transmitter.

■ 23. GUN DATA COMPUTER TRANSMITTERS.—The transmission units built into gun data computers contain essentially the

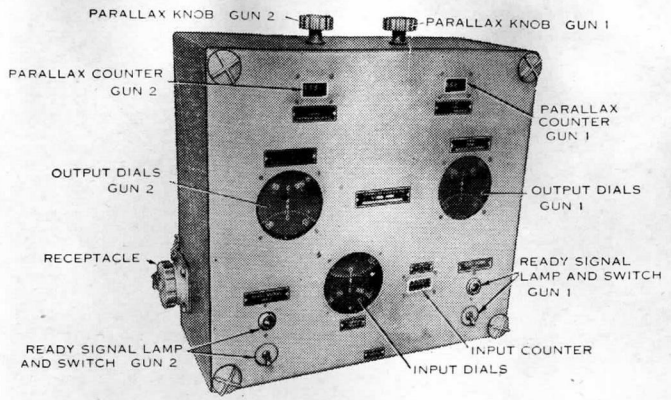

FIGURE 16.—Elevation transmitter M6.

same elements as do the standard transmitters. A coarse and a fine transmitter are provided for the transmission of azimuths to each gun of a two-gun battery, and a coarse and a fine elevation transmitter are provided for each gun. The transmitters are positioned by the computer and any necessary parallax corrections are made by the computer. Each selsyn transmitter carries dials so that transmitted data can be read at the computer.

■ 24. AZIMUTH INDICATORS M5, M6, M9, AND M16.—*a.* As has been pointed out, the azimuth indicators (see fig. 17) differ only in the physical attachment of the indicators to the carriages and in the mechanical indicator drive mechanism. Each has a coarse and a fine selsyn receiver to match the coarse and fine transmitter. The inner dials of the indicator are actuated by the selsyn receiver and indicate the azimuth at which the gun should be set. The outer dial is geared to the base ring and indicates the actual azimuth at which the gun is set. When the two pointers are matched, the piece is set at the transmitted azimuth, and that azimuth may be read on the graduated circle opposite the pointers.

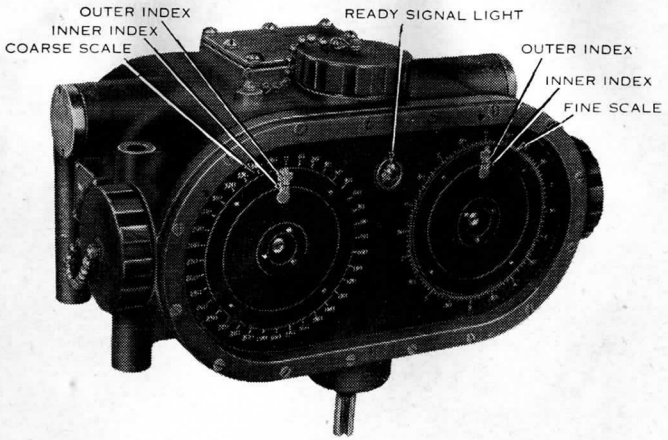

FIGURE 17.—Azimuth indicator.

b. For purposes of synchronization, slotted adjusting shafts for the coarse and fine inner pointers are located under the indicator signal lamp cover. (See par. 30.) For purposes of orientation, an adjustable coupling is provided in the indicator drive shaft.

■ 25. ELEVATION INDICATORS M5, M8, M10, AND M17.—*a.* Elevation indicators (see fig. 18) vary in the same manner as the azimuth indicators. Each has a coarse and a fine selsyn receiver and a coarse and a fine dial positioned by the receivers. The coarse and fine mechanical elevation indicators operate concentrically with these dials. When the pointers are matched, the gun is set at the transmitted elevation, and that elevation may be read on the graduated circle opposite the pointers.

b. The mechanisms for adjustment are the same as those provided on the azimuth indicators.

■ 26. CABLES AND JUNCTION BOXES.—*a.* Cables and junction boxes are used to connect the system. Armored cable is used from the plotting room to the emplacement. Figure 12 shows

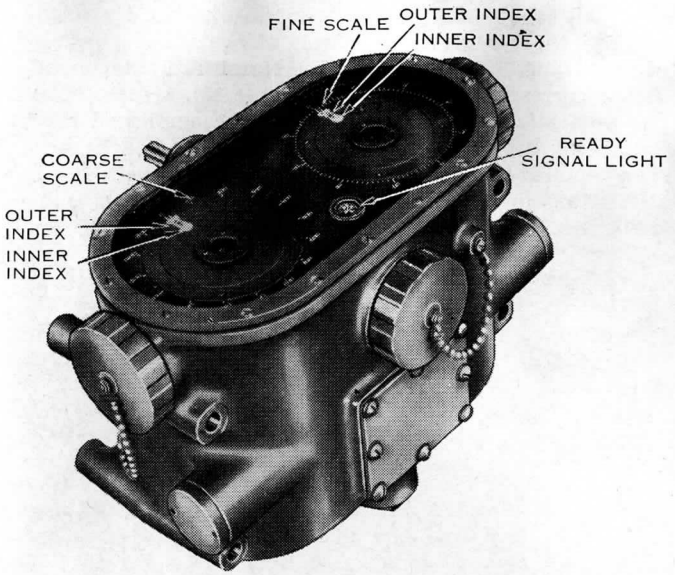

FIGURE 18.—Elevation indicator.

an installation using one plotting room. When it is necessary to use the regular transmitters in one plotting room and the gun data computer in another, the system may be used by the addition of extension junction boxes and armored cable. Cable terminating in an extension junction box in each plotting room is used. The main junction box is placed in the plotting room containing the gun data computer. The main junction box may then be connected to either the data computer or the extension junction box by the flexible couplings. In the second plotting room the transmitters are connected to the extension junction box.

b. The main junction box (see fig. 19) is supplied as a convenient means of connecting both the elevation and azimuth transmitters for each gun to the proper receivers on the particular gun through a single cable. The internal connections in the main junction box are such that the

terminals of the Az. Tr. receptacle which supply azimuth for gun No. 1 and the terminals of the El. Tr. receptacle which supply elevation for gun No. 1 are all connected to the corresponding terminals of the No. 1 receptacle. A like separation and combination are accomplished for the data being supplied to gun No. 2. All data to each gun are then supplied through a single cable. The 115-volt, 60-cycle, alternating-current power required to operate the system is supplied to it at the receptacle marked POWER, and is

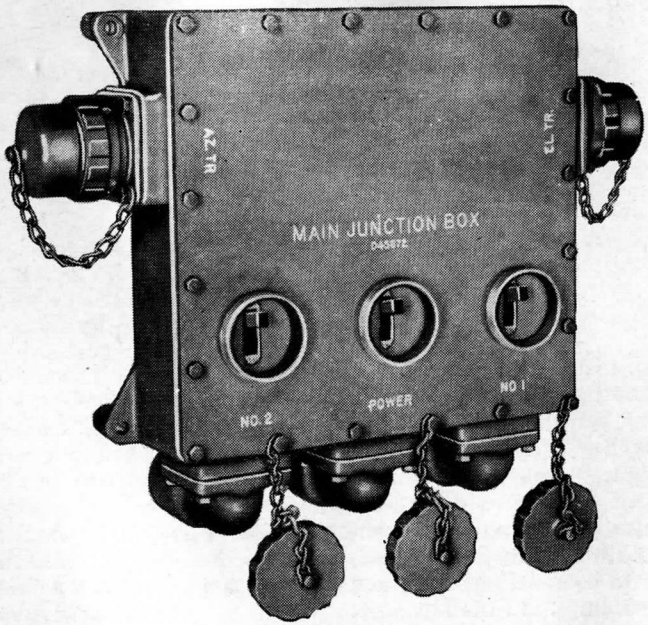

FIGURE 19.—Main junction box.

normally furnished from the post power supply. An auxiliary power plant may be used when necessary, but none is furnished specifically for the purpose. A switch is supplied at the POWER receptacle so that the gun data transmission

system may be energized at the main junction box. Similar switches are supplied at the No. 1 and No. 2 receptacles so that the receivers at each gun may be energized independent of each other.

■ 27. OPERATION WITH STANDARD TRANSMITTERS.—*a.* With the power OFF, connect the azimuth transmitter and the elevation transmitter to the corresponding marked receptacle in the main junction box, using the cable and plug assemblies provided. Make certain that the proper cables are used.

b. Apply power by throwing the power switch in the main junction box to ON. The gun switches marked *No. 1* and *No. 2* should be ON during operation and may be left ON even when the POWER switch is OFF. If a gun switch is thrown OFF during operation, the corresponding azimuth and elevation indicators will not operate and the ready signal lamps will not light.

c. The azimuth and elevation input data are set into the corresponding transmitters at the plotting room by turning the input handwheels until the input data dials read correctly. Parallax corrections for each gun are set by turning the corresponding parallax knobs until the correct parallax correction appears on the adjacent counter. After checking the transmitted azimuth dials to see that no error exists, the operator will throw the ready signal switch ON.

d. The azimuth and elevation setters of the gun sections match their pointers to set the firing data on the guns.

■ 28. OPERATION WITH A GUN DATA COMPUTER.—The operation of the system when using a gun data computer is the same as that set forth in *a* above except that the azimuth and elevation transmission cables from the computer are plugged into the main junction box in place of those from the standard transmitters, and data are continuous.

■ 29. ORIENTATION.—*a.* For purposes of orientation, an adjustable coupling is located in all the mechanical indicator drive shafts. (See fig. 20.) The adjustable coupling consists of an adjusting worm and a clamping screw.

b. Set the piece accurately at a known azimuth or elevation, loosen the clamping screw, and turn the adjusting worm until the mechanical indicator reads the correct azimuth or elevation. Tighten the clamping screw and check the orientation.

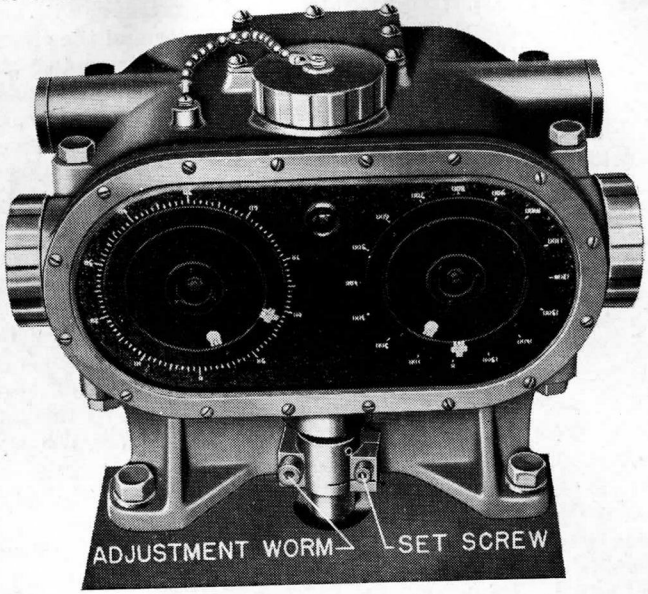

FIGURE 20.—Indicator showing adjustable coupling in drive shaft.

■ 30. SYNCHRONIZATION OF RECEIVERS WITH TRANSMITTERS.—*a.* Synchronization is the adjustment of the indicator inner dial indexes to the same reading as the corresponding transmitter dials.

b. Synchronization is performed with the system energized. It should seldom be necessary to alter the synchronization adjustment, but the adjustment should be verified habitually upon manning equipment and at frequent intervals during drills or alerts.

c. Slotted adjusting shafts for the coarse and fine indicator inner dials are located under the indicator signal lamp

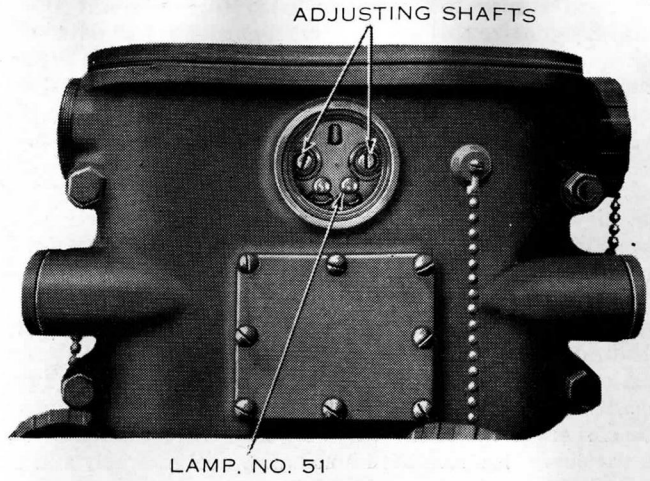

FIGURE 21.—Indicator showing adjusting shafts.

cover. (See fig. 21.) The motion of these shafts is limited to the few turns sufficient to provide adjustment under all normal conditions. No attempt should be made to force a shaft if a stop is encountered.

d. To synchronize the azimuth or elevation indicator, energize the system and note the reading of the coarse and fine transmitter output dials. By means of the slotted adjusting shafts, set the inner coarse and fine indexes of the indicator to read the same as the corresponding transmitter output dials.

e. Do not attempt to synchronize if the direction of rotation of any indicator index is reversed or if there is a large departure from synchronization.

■ 31. SYNCHRONIZATION OF TWO TRANSMITTERS.—*a.* Synchronizing adjustments performed with the standard azimuth and elevation transmitters will normally hold for gun data computer transmitters. If the adjustment does not hold when the gun data computer is used in place of the standard transmitters, it will be necessary to adjust the

standard transmitter to agree with the computer transmitter. To make this adjustment, connect the gun data computer and synchronize the indicators with it. Then replace the computer with the standard transmitters. Remove the covers from the transmitters requiring adjustment. (See *b* below.) Loosen the three screws in the clamping washer of the transmitter dial, and shift the dial on the transmitter shaft to bring it into agreement with the inner index on the indicator. Tighten the three screws to retain the adjustment, check the adjustment, and replace the transmitter cover.

b. The transmitter covers should be removed *only* when authorized adjustments are required, and then only in a clean, dust-free room. Care should be taken to see that no dirt or foreign matter gets in the transmitter during adjustment. To remove the cover, unscrew the four wing nuts at the corners of the cover. The wing nuts will remain attached to the cover. Remove the input handwheel assembly and the two parallax knob assemblies. Each is secured by a wing knob at its center. Lift the cover straight up. Proceed carefully so as to clear the studs and mechanisms. The wing nuts may be used as grips for lifting the cover. To replace the cover, line it up carefully in its original relation with the transmitter case, ease it down into position, tighten the wing nuts, and replace the input handwheel and parallax knob assemblies.

■ 32. ADJUSTMENT OF PARALLAX COUNTERS.—To adjust the parallax counters of the standard transmitters to any required *normal* setting, remove the cover and temporarily replace the input handwheel and parallax knob assemblies. Turn the parallax knobs to bring the output dials into agreement with the input dials. Remove the counter from the counter bracket by removing four screws and washers and pulling the counter straight up off the dowel pins which locate it. Set the counter to read the required reading and reassemble the counter on the counter bracket, meshing the gears carefully so as not to alter the setting. Replace and tighten the four screws which hold the counter. Replace the transmitter cover.

■ 33. MAINTENANCE ADJUSTMENTS.—*a.* The adjustments that can be made by the using arm are limited to the routine adjustments of orientation and synchronization, as herein stated, and to the replacement of lamp bulbs.

b. Lamps used in the azimuth and elevation transmitters are Mazda No. 1002 type (10-watt, 125-volt; S8 bulb). The lamps can be replaced after removal of the transmitter cover. Lamps used in the azimuth and elevation indicators are Mazda No. 51 type (1-c.p., 6- to 8-volt, 0.2-ampere; G3½ bulb). The lamps can be replaced after removal of the lamp well covers. (See fig. 22.)

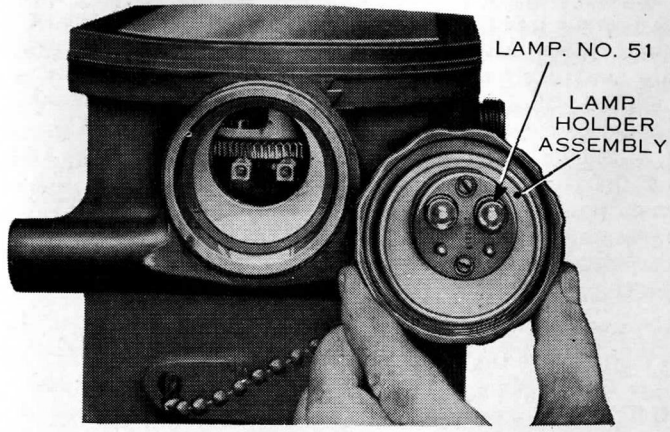

FIGURE 22.—Indicator showing lamp holder assembly.

■ 34. CARE AND PRESERVATION.—*a.* Power should be switched off before cables are connected or disconnected. See that cables are securely held in the receptacles before turning the power on.

b. Do not kink or twist the cables. Avoid bending the cables on a short radius or allowing them to chafe against moving parts. Keep the cable clean of oil or grease. To remove oil or grease, wipe the area as clean as possible and then wash with soapy water.

c. When cables are not connected, keep the plugs and receptacles closed with the covers provided.

d. When cables are connected, keep the plugs and receptacles tightened firmly together by means of the round nuts provided. Screw the plug and receptacle covers together to keep them from dangling and to protect the threads.

e. When disconnecting a cable, pull on the body of the plug. Do not pull on the cable or spring.

f. The indicators and transmitters do not require lubrication when in service. Such lubrication as is necessary is performed only in connection with major disassembly or overhaul by Ordnance.

g. Should a receiver start to "run away" (run as a motor runs at a high rate of speed), cut off the power immediately to prevent injury to the coils by overheating and then reapply power after the receiver comes to rest. Receivers are most likely to run away at the instant when power is supplied. If a receiver runs away often, local Ordnance should be consulted.

h. Should a receiver bind or stick during operation, turn off the power to that gun by means of the switch in the main junction box. A binding or sticking receiver will cause inaccurate transmission of data to the corresponding receiver on the other gun and will be subject to injury by overheating.

■ 35. MISCELLANEOUS.—The following are symptoms of faults which require the attention of trained Ordnance personnel:

a. One or more receivers rotate in opposite direction from transmitter.

b. One or more receivers fall out of synchronization during part of a revolution of the dial.

c. One or more receivers fail to synchronize, remaining inoperative.

d. One or more receivers lag behind the transmitter in both directions of rotation. (If a receiver lags in one direction and leads in the other, synchronization is required.)

e. One or more receivers remain stationary for a time, suddenly rotate 180°, and again remain stationary.

f. Receiver fails to come to rest but oscillates about its central position.

SECTION IV

DESTRUCTION OF MATERIEL

Paragraph
General principles 36
Base-end data transmission system 37
Gun data transmission system 38

■ 36. GENERAL PRINCIPLES.—*a.* Tactical situations may arise when, owing to limitations of time or transportation, it will become impossible to evacuate all equipment. In such situations it is imperative that all materiel which cannot be evacuated be destroyed as completely as the available time and personnel will permit to prevent:

(1) Its capture intact by the enemy.

(2) Its use by the enemy, if captured, against our own or allied troops.

(3) Its assembly by the enemy into complete units from salvaged parts.

b. The working principles to be followed are:

(1) Methods for the destruction of materiel subject to capture or abandonment in the combat zone must be adequate, uniform, and easily followed in the field.

(2) If thorough destruction of all parts cannot be completed, those parts essential to the operation of the materiel and which cannot be easily duplicated should be destroyed or removed. *The same essential parts must be destroyed on all like units to prevent the enemy's constructing one complete unit from several damaged ones by cannibalization.*

(3) The destruction of materiel, subject to capture or abandonment in the combat zone, *will be undertaken only when in the judgment of the military commander concerned such action is necessary.*

(4) The gun data transmission system and the base-end data transmission system will be destroyed in conjunction with the destruction of the guns and of the fire control equipment in the base-end stations and in the plotting room.

c. To accomplish adequate and uniform destruction of materiel, it is essential that:

(1) All echelons prepare plans for the destruction of materiel in the event of imminent capture. Such plans must be flexible as to the available time, equipment, and personnel.

(2) All echelons be trained to effect the desired destruction of materiel issued to them. *Training will not involve the actual destruction of materiel.*

■ 37. BASE-END DATA TRANSMISSION SYSTEM.—*a. Materiel to be destroyed.*

(1) Transmitters.
(2) Receivers.
(3) Line balancer.
(4) Aided-drive mechanisms.
(5) Switchboards.
(6) Transmission lines.

b. Methods of destruction.—(1) Items 1-5 inclusive, listed in *a* above, may be destroyed by thoroughly smashing them with a sledge or ax. After smashing, pour gasoline on the equipment and ignite.

(2) Item 6 may be destroyed by cutting the lines into short lengths and burning them with gasoline if time is available.

■ 38. GUN DATA TRANSMISSION SYSTEM.—*a. Materiel to be destroyed.*

(1) Transmitters.
(2) Indicators.
(3) Junction boxes.
(4) Receptacles and plugs.
(5) Transmission cables.

b. Methods of destruction.—(1) Items 1-4 inclusive, in *a* above, may be destroyed by thoroughly smashing them with a sledge or ax. After smashing, pour gasoline on the equipment and ignite.

(2) Item 5 may be destroyed by cutting the lines into short lengths and burning them with gasoline if time is available.

APPENDIX I

LIST OF REFERENCES

Service of the Piece—Gun Data Computer M1....FM 4–30
Instruction Guide—Gun Data Computer M1....TM 9–2646
Ordnance Maintenance—Gun Data Computer M1.TM 9–1646
Seacoast Artillery Fire Control and Position Finding .....FM 4–15
6-Inch Seacoast Materiel:
6-Inch Guns M1903A2 and M1905A2; Barbette Carriage M1.....TM 9–428
8-Inch Seacoast Materiel:
Gun Mk. VI Mod. 3A2; Barbette Carriage M1.....TM 9–442
Gun, 8-Inch Mk. VI, Mod. 3A2 and Mount, Railway, Gun, 8-Inch, M1A1.....TM 9–463
16-Inch Seacoast Gun Materiel:
Gun Mk. II M1, Barbette Carriage M4.....TM 9–471

APPENDIX II.—DRILL FOR BASE-END DATA TRANSMISSION SYSTEM

(*Operations are performed in the numerical order shown. The drill is not a precision drill.*)

Command or action	Observer	Reader	Operator, receiver
(1) Upon opening of station and posting of details.	(1) Inspects equipment; levels and orients instrument; checks communication.	(1) Inspects equipment; checks communication.	(1) Inspects equipment; checks communication.
	(4) Sets switch on BALANCE position, calls, "Set."	(3) Repeats, "Set switch on balance."	(2) Calls, "Set switch on balance"; turns bridge circuit power ON.
		(5) Repeats, "Set."	(6) Turns LINE BAL SW to left (position 1); adjusts left-hand (1) LINE BAL knob until meter pointer is at midscale; turns LINE BAL SW to right (position 2); adjusts right-hand (2) LINE BAL knob until meter pointer is at midscale; repeats balancing operation if left- and right-hand knobs were moved more than 45 degrees; turns LINE BAL SW to TR position; calls, "Set switch on track."
	(8) Sets switch on TRACK position; calls, "Set."	(7) Repeats, "Set switch on track."	
		(9) Repeats, "Set."	(10) Checks several settings of the hundredths dial with the reader to see that line balance is correct; turns bridge circuit power OFF.
	(11) Reports, "(B1) in order."	(11) Reports, "Azimuth transmitter in order."	(11) Reports, "Azimuth receiver in order."

(12) TARGET; (water area); (ship); (class); (direction of travel); (stations).	(12) Identifies target; traverses instrument to observing point; reports, "(B1) on target."	(12) Takes position to read from observer's instrument.	(12) Turns bridge circuit and motor power ON; operates SLEW KEY to bring degree dial to approximate azimuth.
(13) TRACK	(13) Turns aided-tracking power ON; tracks target.	(14) Calls off each degree as vernier of observer's instrument passes through 0, or calls off complete reading at intervals of about 10 seconds for slow target.	(14) Adjusts aided-matching handwheel until meter pointer remains centered; operates SLEW KEY until dial indicates proper whole degree as received from reader. When certain that reading is correct, reports, "Data O.K.," and continues to match.
(15) CEASE TRACKING	(15) Ceases to track; turns aided-tracking power OFF.		(15) Ceases to match; turns bridge circuit and motor power OFF.
(16) CLOSE STATION	(16) Secures equipment	(16) Secures equipment	(16) Secures equipment.

APPENDIX III.—DRILL FOR GUN DATA TRANSMISSION SYSTEM

a. With plotting board and standard transmitters.–Operations under *a* are performed in the numerical order shown. The drill is not a precision drill.

Command or action	Azimuth or elevation transmitter operator	Parallax correction setter	Gun pointer or elevation setter
Upon opening of plotting room and manning of guns.	(1) With power OFF, plugs transmitter into proper receptacle of main junction box. Turns power switch ON. Turns gun switches ON. Checks communication with gun pointer (elevation setter). Checks synchronization with gun pointer (elevation setter).	(1) Sets parallax corrections at normal.	(1) Checks communication with transmitter operator. Assists transmitter operator in checking synchronization and makes any necessary adjustment.
During drill or firing...	(2) Sets firing azimuth as called from deflection board (elevation from percentage corrector) on input dials. (4) Checks transmitted azimuth (elevation) dials to see that no error exists, and turns ready signal switch ON. (6) Turns ready signal switch OFF after each time-interval bell.	(3) Sets proper azimuth (elevation) parallax corrections as indicated on the parallax correction chart for the battery.	(5) Matches pointers to set firing data on gun.
CLOSE STATION.....	(7) Turns power and gun switches OFF. Secures equipment.	(7) Secures equipment.....	(7) Secures equipment.

b. With gun data computer.—No drill is prescribed for operation with a gun data computer because the computer operates the system when it is properly connected. Prior to firing, the chief of the range section will see that the cables from the computer are plugged into the proper receptacles of the main junction box and that the power and gun switches are turned ON. He will check the synchronization with the gun pointer and elevation setter. He will turn the ready signal switch ON when the range officer reports, "Data smooth," and will leave it ON, as long as the data are good, to indicate that continuous firing data are being supplied to the guns. At the command CLOSE STATION, he will see that the gun and power switches are turned OFF.